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APPLICATIONS OF SYSTEMS ENGINEERING TECHNIQUES TO UNIFIED LIFE CYCLE ENGINEERING

Activities and Accomplishments in Fiscal Year 1989

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January 1990

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Office of the Under Secretary of Defense for Acquisition
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This document summarizes the work performed by the Institute for Defense Analyses on Task T-D6-553, "Applications of Systems Engineering Techniques to Development of a Unified Life Cycle Engineering Environment," during FY 1989. These activities included supporting a strategic planning process at the Air Force Human Resources Laboratory, Logistics and Human Factors Division (AFHRL/LR), and providing technical support to AFHRL/LR in its conduct of its research and development program on Reliability and Maintainability in Computer-Aided Design (RAMCAD)

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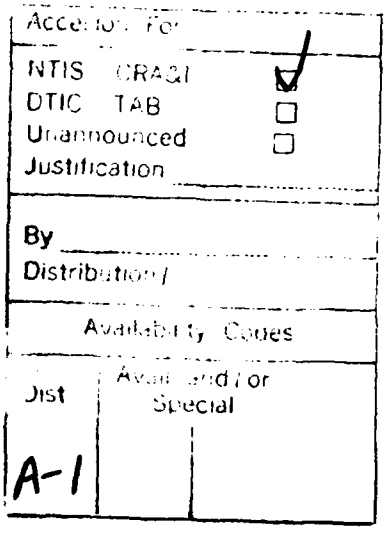

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PREFACE

This paper is the result of work performed by the Institute for Defense Analyses (IDA) under contract number MDA 903 89 C 0003, Task Order T-D6-553, Amendment Number 3, "Applications of Systems Engineering Techniques to the Development of a Unified Life Cycle Engineering (ULCE) Environment." This work was performed for the Air Force Human Resources Laboratory, Logistics and Human Factors Division, and the Under Secretary of Defense for Acquisition (USD(A)). The document satisfies subtask 5.f, which requires that IDA provide the sponsor with a summary report of its activities and accomplishments during FY89 that were related to this task.

This paper was reviewed by Dr. Joel E. Tumarkin, an IDA consultant.

CONTENTS

ACTIVITIES IN FISCAL YEAR 1989

The purpose of this document is to outline the activities and accomplishments of the Institute for Defense Analyses (IDA) on Task T-D6-553, Applications of Systems Engineering to Unified Life Cycle Engineering (ULCE), during fiscal year 1989 (FY89). The two main thrusts of the task during FY89 have been

(1) Support for the Air Force Human Resources Laboratory/Logistics and Human Factors Division, Logistics Systems Branch (AFHRL/LRL), strategic planning process

(2) Technical support for the Reliability and Maintainability in Computer-Aided Design (RAMCAD) research and development program being conducted by AFHRL and the US Army Armament Research and Development Center (ARDEC).

This document addresses work performed for AFHRL or for AFHRL and ARDEC. Work performed solely for ARDEC is documented in Reference 1. Overall sponsorship for this task resides with the Office of the Deputy Director of Defense Research and Engineering, Research and Advanced Technology (DDR&E/R&AT). Funding was provided by AFHRL and ARDEC.

A. STRATEGIC PLANNING SUPPORT

During FY89, IDA provided support for the AFHRL/LRL strategic planning process that was similar to support IDA has provided for various Department of Defense (DoD) organizations seeking to develop strategies and implementation plans to address complex problems. For AFHRL, the planning task involved identifying core research thrust areas and developing a specific research program relating to concurrent engineering, a DoD-wide initiative with the goals of improving weapon system quality, shortening development lead time, and reducing system cost through an improved engineering design process.

AFHRL has been conducting research that is closely related to concurrent engineering for some years, through programs such as RAMCAD, the Integrated Design

Support System (IDSS), and man-modelling systems such as CREW CHIEF. In December 1988, two branches within AFHRL, Acquisition Logistics (LRA) and Logistics Systems (LRL), were integrated into a single branch. A strategic planning activity was commenced shortly after the merger with the goal of better charting the direction and program of the new branch for the 1990s. IDA, having supported a number of DoD strategic planning efforts, was tasked by AFHRL to support this planning effort.

IDA's planning support for AFHRL fell into the following categories:

- Developing an implementation plan for strategic planning at AFHRL
- Providing basic education for AFHRL in strategic planning--defining strategic planning and steps for implementation
- Preparing a two-day course for AFHRL on the state of the art in concurrent engineering and how concurrent engineering relates to other design-related initiatives
- Facilitating the strategic planning process through support for group meetings and documentation and dissemination of meeting minutes
- Assembling a draft strategic plan for review and modification by the lab.

1. Development of Implementation Plan

Working together with AFHRL personnel, IDA developed a draft implementation plan for the AFHRL strategic planning process. This plan addressed

- The goals of the strategic planning effort
- Anticipated benefits from the strategic planning process
- The schedule of meetings and other strategic planning activities
- A strawman outline of the strategic plan
- A set of questions that IDA recommended that the lab address prior to commencing the planning process.

2. Strategic Planning Tutorial

During the initial AFHRL strategic planning meeting on March 13, 1989, IDA presented a short tutorial on strategic planning. The tutorial defined strategic planning, outlined how strategic planning is usually accomplished in a corporate setting, emphasized the need for group involvement to engender a sense of ownership among those who must implement the plan, and discussed potential pitfalls to be avoided in the planning process.

3. Concurrent Engineering Training

On March 28 and 29, 1989, IDA presented a short course on concurrent engineering to personnel from AFHRL/LRL and the Wright Research and Development Center Concurrent Engineering Branch (WRDC/MTC). The purpose of the course was to provide background in concurrent engineering that would enlighten laboratory personnel who would be involved in the planning process. In particular, the relationship of concurrent engineering to other initiatives such as RAMCAD and ULCE was addressed. The course outline was as follows:

- Course introduction
- History and background of the AFHRL/ARDEC RAMCAD program
- IDA studies in ULCE, including the relationship between ULCE and concurrent engineering
- Introduction to concurrent engineering, including the findings of the IDA Concurrent Engineering Study
- Concurrent engineering and the weapon systems acquisition process
- Research and development issues in concurrent engineering
- The Defense Advanced Research Projects Agency (DARPA) Initiative in Concurrent Engineering (DICE)
- Decision support issues in concurrent engineering.

The course was taught by IDA personnel and augmented by several outside experts. These experts included

- Professor Daniel Schrage of Georgia Institute of Technology (formerly Director of Advanced Systems at the US Army Aviation Systems Command), who spoke on the relationship between concurrent engineering and the acquisition process
- Professor Michael Wozny of Rensselaer Polytechnic Institute (formerly Director of the Division of Design, Manufacturing, and Computer-Integrated Engineering at the National Science Foundation and currently participating in DARPA's DICE Program), who spoke on R&D issues in concurrent engineering and on DICE
- Professor Farrokh Mistree of the University of Houston (currently director of the Systems Design Laboratory in the Mechanical Engineering Department), who spoke on decision support requirements for concurrent engineering.

Course participants received a comprehensive set of course materials, including copies of the instructors' presentations and background material on concurrent engineering and total quality management (TQM). The material presented by IDA on the RAMCAD program and on IDA's ULCE study program was also incorporated into two documented briefings provided to AFHRL.

4. IDA Support for the Strategic Planning Meetings

After the concurrent engineering course, AFHRL commenced the strategic planning process through a series of group meetings in which all program managers, the chief scientist, and the LRL branch manager participated. These meetings were held on April 27, 1989; May 8, 1989; May 26, 1989; and June 22, 1989. IDA supported these meetings as follows:

- IDA arranged for the meetings to be held off site (at the Bergamo Center in Dayton, Ohio) to minimize disruptions from daily business and allow the meeting participants to concentrate fully on the planning task.
- IDA facilitated conduct of the meetings using a computer projection system that has been found to be advantageous, in previous IDA strategic planning support efforts, in focusing group attention.
- After each meeting, IDA provided AFHRL with meeting minutes and documentation of homework assignments to be completed by participants prior to the next meeting.
- IDA personnel maintained a running account of the progress of the planning effort on the computer, allowing traceability of strategic planning decisions as the planning process proceeded. This procedure also facilitated development of the draft planning document.

5. Support in Assembly of Draft Strategic Plan

At the conclusion of the first phase of the planning process (the four group meetings and several internal AFHRL meetings), IDA assisted AFHRL in assembling the planning materials, provided by meeting participants, into a draft plan. The contents of the plan were provided by laboratory personnel who participated in the planning process. This is important in view of the fact that a strategic planning process, to be successful, must be accomplished by those who will implement the plan. A plan developed by persons outside an organization, such as management consultants, is unlikely to be accepted or implemented within that organization.

IDA supervised production of the planning document and made several recommendations to AFHRL on ways that the document could be improved. At the conclusion of the FY89 planning process, IDA participated in a meeting on October 11, 1989, held at AFHRL, where these recommendations were discussed and AFHRL finalized the form and content of the document. IDA then assembled draft final versions of the strategic plan and a working paper on research thrust areas, which were forwarded to AFHRL.

B. TECHNICAL SUPPORT FOR THE RAMCAD PROGRAM

IDA has provided technical support to the AFHRL RAMCAD program office since the program's inception in 1987. This support has consisted of review of the contractor's deliverables and status reports, participation in contractor review meetings, participation in the RAMCAD curricula development workshops, and assessment of the contractors' technical progress for AFHRL. IDA is uniquely qualified to provide this support in view of its long-term involvement with RAMCAD and closely related DoD initiatives, including Computer-Aided Acquisition and Logistics Support (CALS) and concurrent engineering.

Technical support provided by IDA in FY89 included the following:

- IDA personnel attended the Reliability and Maintainability (R&M) Symposium in Atlanta, Georgia, and reported on the latest trends in the R&M community to AFHRL.
- IDA personnel prepared and delivered a briefing to the AFHRL General Dynamics (GD) RAMCAD Program Manager that outlined the history of the RAMCAD program and IDA's support of AFHRL/ARDEC. A similar briefing was also delivered on the Boeing portion of the RAMCAD program to the AFHRL Boeing RAMCAD Program Manager.
- IDA personnel met with the AFHRL and ARDEC RAMCAD Program Managers at IDA to review the status of the program and prepare for the GD Preliminary Design Review (PDR).
- IDA personnel attended the GD PDR and provided comments via a memo to the RAMCAD program office.
- IDA reviewed four versions of each of the documents presented at the GD PDR: the Software Development Plan, the System Integration Plan, and the RAMCAD Detailed Research Plan.
- IDA also reviewed additional PDR material after the PDR was held.
- IDA reviewed Boeing Contract Data Requirements List (CDRL) item 10.

- IDA reviewed reports of 1988 activities of the Boeing subcontractors.
- IDA personnel attended the ARDEC Product Assurance Forum in April 1989.
- An IDA representative attended a review meeting at Boeing with the AFHRL Boeing Contract Manager.
- An IDA representative attended the University of Maryland Center for Computer-Aided Life Cycle Engineering (CALCE) industry members workshop and reported on the results to AFHRL.
- An IDA representative attended the RAMCAD Curriculum Development workshop held in June 1989 and prepared a memo discussing the curriculum development effort and providing recommendations for further direction in this area.
- IDA representatives attended the RAMCAD technical interchange meeting held at AFHRL in June 1989. A memorandum outlining IDA's conclusions and recommendations based on the meeting was forwarded to AFHRL.
- IDA reviewed the Boeing Casebook (CDRL 12) and provided comments to AFHRL.
- IDA personnel attended RAMCAD reviews at Boeing and General Dynamics in September 1989.
- IDA arranged and attended a briefing for AFHRL on TRW's concurrent engineering program in September 1989.
- IDA presented a briefing in October 1989 on the current status of the RAMCAD program and recommended future research thrusts related to RAMCAD.
- IDA published a report outlining the RAMCAD program from the General Dynamics perspective (for ARDEC).

REFERENCE

1. Hill, G. Watts, and Riddell, Frederick R., *The Army/Air Force RAMCAD Program, Progress Report to September 1989*, Institute for Defense Analyses, January 1990.

DISTRIBUTION

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